

SCIENCE OBJECTIVES IN THE LUNAR BASE ADVOCACY

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Rationale for a Lunar Base

As we approach the 21st century, the U.S. manned space program will focus on the operation and evolution of low Earth orbit (LEO) space stations and the development of orbital transfer vehicles (OTV's). From that time forward, manned space activities will consist no longer of simple orbital sorties; permanent presence on station will be an intrinsic element of new programs.

The deployment of reusable upper stages (OTV's) at the LEO station will have enormous significance. Within the context of the Space Transportation System, the reusable OTV has been seen as a service vehicle for operations in geosynchronous orbit (GEO), which lies at the very edge of the Earth's gravitational sphere of influence. Designed to escape the Earth's grasp and return, the OTV will allow access to all of cislunar space, including inevitably the surface of the Moon.

We argue that the establishment of a lunar base will become a major space policy issue by the time this transportation element enables routine visits to the Moon. Awareness of the implications of this technology is most likely to occur within the next 10 years, as the manned LEO space station becomes a reality. In anticipation of a future public debate, scientists, technologists, and policy analysts within and outside NASA have been devoting some thought to the lunar base issue. A well-studied base of information will be critical to the success of the decision process.

As a first step, we have made technical and budgetary projections as conservatively as possible, and the results appear to confirm the feasibility of establishing a permanently manned lunar base by the first decade of the 21st century. However, the scale of project envisioned would require a long-term commitment. From the experience with the Apollo Program, we learn that the political process will not continue support without a clear payback in terms of the economy, of social goals, or of national security. Viability of continuous lunar surface operations over the long term will depend on attainment of a high degree of self-sufficiency in space and therefore on the exploitation of any economic potential for the use of lunar resources. Consequently, we tend to focus on strategies which maximize use of local materials and the local environment to minimize the high transportation costs associated with imports from the Earth.

Research on the Moon

The success of planetary surface operations such as mining, surface transportation, construction, and industrial processing will depend on the adaptation of technologies to the lunar environment. Thus, we anticipate that a significant fraction of the man-hours spent on the surface in early missions will be devoted to applied research. The scope of the exploratory experimentation could range from geological surveys of potential lunar resources to studies of the effects of reduced gravity on chemical engineering designs to measurements of surface properties appropriate to civil engineering.

Although learning to function in the lunar environment will be a major task for early selenauts, a lunar base program must include important basic research as a high-priority activity.

Advancement of human understanding of the physical world accompanies the opening of any new frontier.

Defining Science Objectives

Definition of potential scientific experiments is important to NASA planners, who must consider the necessary equipment and operational requirements imposed by the investigations. Conversely, scientists need to seek out opportunities to participate in planning. A failure to do so means that engineering and technological goals preempt resources which could be used for research.

Since lunar base planning has not been a NASA activity with high visibility or significant financial support, there has been a problem getting inputs from a representative cross section of the scientific community. The exception has been lunar and planetary science, which has an intimate connection with NASA. For the most part, scientists are unaware of the problem or consider the scenario to be excessively speculative and remote or have little knowledge of the lunar environment and its potential advantages to scientific investigations.

Those involved in lunar base planning have tried to bring scientists of diverse backgrounds together in workshops or symposia to discuss possible experiments uniquely suited to the Moon or unusually enhanced by being performed in the lunar environment. However, the financial resources for sponsoring such meetings are very limited. One successful communication mechanism is the convening of special sessions, such as this one, at professional meetings. In general, the sessions are conceived, organized, and advertised by interested professionals. The meetings not only communicate the potential opportunities for science in future space projects but also bring together researchers of similar backgrounds for good, old-fashioned brainstorming. Out of such gatherings can come excellent ideas for innovative experiments in the space environment.

For the lunar base, we are most interested in basic research which can be done only on the Moon or can be done best there. Once humans live on the Moon, many experiments will be done simply because it is convenient. However, in preparing for a decision on whether to embark on a Moon base, we must determine the major advances in knowledge and understanding that would be enabled by the enterprise. Although science is rarely the sole justification for major public policy decisions, it is always a full partner to exploration; thus, it is important to be sure that the scientific rewards of the endeavor are fully understood and exploited.